Early Journal Content on JSTOR, Free to Anyone in the World

This article is one of nearly 500,000 scholarly works digitized and made freely available to everyone in the world by JSTOR.

Known as the Early Journal Content, this set of works include research articles, news, letters, and other writings published in more than 200 of the oldest leading academic journals. The works date from the mid-seventeenth to the early twentieth centuries.

We encourage people to read and share the Early Journal Content openly and to tell others that this resource exists. People may post this content online or redistribute in any way for non-commercial purposes.

Read more about Early Journal Content at http://about.jstor.org/participate-jstor/individuals/early-journal-content.

JSTOR is a digital library of academic journals, books, and primary source objects. JSTOR helps people discover, use, and build upon a wide range of content through a powerful research and teaching platform, and preserves this content for future generations. JSTOR is part of ITHAKA, a not-for-profit organization that also includes Ithaka S+R and Portico. For more information about JSTOR, please contact support@jstor.org.

THE RELATION BETWEEN FORESTRY AND GEOLOGY IN NEW JERSEY

ARTHUR HOLLICK.

II. Historical Development of the Flora.

Within the boundaries of the state are geological formations representing all the great time divisions — Eozoic, Palæozoic, Mesozoic, and Neozoic — and rocks of all the included geologic periods, with the exception of the Carboniferous and Jurassic.

In tracing the development of plant life through geologic time the fact is well recognized that the flora of Eozoic and Palæozoic times is not related to our living flora by any closer ties than those of sub-kingdoms or classes. In Mesozoic time generic relationships may be traced, while in Neozoic time many species either identical with or closely related to living ones may be recognized.

It has also been accepted as a broad generalization that biologic development has been coincident with geologic sequence, or, in other words, that the farther back in geologic time we begin our investigations the lower in the scale of life we find the plants to be ; and, conversely, that the nearer we approach modern time the higher they are in development. Plants have developed in the past in accordance with changes in their environments, as they do to-day, so that in order to understand the evolution of any living flora it is necessary to know something about the changes which have preceded the existing conditions.

For the purposes of this discussion we need not begin any farther back in geologic time than the Triassic period, when the shore line of the North American continent, so far as New Jersey is concerned, extended irregularly from about the vicinity of Mahwah to a few miles south of Phillipsburg. This was evidently a period of slow subsidence, and the Triassic deposits were largely laid down in shallow estuaries or lagoons, which were alternately covered with the tides and exposed to the atmosphere. The rocks are mostly conglomerates, sandstones, and shales, evidently shore or shallow water deposits, often ripple-marked or sun-cracked, and occasionally bearing the footprints of land animals or amphibians which wandered over them.

The vegetation of the period is but sparsely represented in the collections which have been made in New Jersey, but these probably fairly represent its general characters. Dr. J. S. Newberry has described about ten species from the state,[1] of which three are pteridophytes, and the remainder probably all referable to the gymnosperms. One living genus (*Equisetum*) is recognized.

Thus far, in any collection of Triassic plants which has been made, nothing higher in development than the monocotyledons is even indicated, and we may regard the Triassic flora as one composed almost wholly of ferns, cycads, and conifers, with cycads as the dominant type.

Towards the close of the Triassic period great physical changes occurred, of which the extrusion of trap dikes was one of the most prominent features. The indications also are that that portion of the continent now represented by New Jersey and vicinity was raised above its former level and remained so for a long time, while farther south it was depressed, as in this state we know of no deposits which can be even provisionally referred to the next succeeding period, the Jurassic, which, however, occur in Maryland and southward. In New Jersey, therefore, we have a break at this period in the geologic sequence, and in consequence a hiatus in the line of plant development which has been at least partially bridged by Prof. Wm. M. Fontaine and Dr. Lester F. Ward in their studies of the Potomac flora of Maryland and Virginia.[2] The exact geologic age of the lower strata of this formation has not been definitely settled, but all the evidence thus far adduced from the fossil plants indicates a transition from the Triassic flora below to the typical Cretaceous flora above.

---

[1] Fossil Fishes and Fossil Plants of the Triassic Rocks of New Jersey and the Connecticut Valley, *Monographs of the United States Geological Survey*, vol. xiv.

[2] Fontaine, Wm. M. The Potomac or Younger Mesozoic Flora, *Monographs of the United States Geological Survey*, vol. xv, pts. i and ii.

Ward, L. F. The Potomac Formation, *Fifteenth Annual Report of the United States Geological Survey*, pp. 307–397.

In this transition flora, accompanying the pteridophytes and gymnosperms, are numerous archaic types of angiosperms and others in which generic relationships with living plants are more or less definitely indicated. Others more closely related are described under such names as *Ficophyllum*, *Sapindopsis*, *Saliciphyllum*, *Quercophyllum*, *Eucalyptophyllum*, etc., while not a few living genera are recognized (*Torreya*, *Sequoia*, *Araucaria*, *Taxodium*, *Sassafras*, *Myrica*, etc.). The number of pteridophytes and gymnosperms as compared with the angiosperms is about 4 to 1, so that the lower types of vegetation were evidently yet in the ascendant.

The limited number of modern elements contained in this and the preceding flora render a comparison with our living flora somewhat hazardous so far as any conclusions as to climate are concerned, but we may safely say that in their general character they indicate tropical or subtropical conditions.

The strata next succeeding the Triassic in New Jersey consist of clays, sands, and gravels, which are apparently Middle Cretaceous in age. This indicates a later submergence of the New Jersey area, when the shore line was approximately where we now find the southern edge of the Triassic outcrop to be, extending from Woodbridge to Trenton.

This was evidently a period of quietude and slow subsidence, as the deposits are largely clays and fine sands in which immense quantities of land vegetation are entombed, many of the specimens being so delicate that it is difficult to understand how they could have been preserved at all, except in very quiet or exceedingly sluggish waters. The occurrence of a few marine molluscs indicates that the waters were at times subject to tidal influence, but essentially they must have been fresh or perhaps brackish.

This flora has been described by Dr. Newberry,[1] who recognized in it 156 species, of which all but about thirty are angiosperms, nearly all of them included under living genera. Many of these now inhabit the region, such as *Diospyros*, *Juglans*, *Liriodendron*, *Magnolia*, *Populus*, *Salix*, etc. ; but others are of more southern distribution, such as *Bauhinia*, *Cinnamomum*, *Eucalyptus*, *Ficus*, *Laurus*, *Passiflora*, *Sequoia*, etc.

---

[1] The Flora of the Amboy Clays, *Monographs of the United States Geological Survey*, vol. xxvi.

No living species is recognized, although close specific relationship is commented upon in several instances, and is indicated in at least one of the names adopted (*Magnolia glaucoides*).

The most significant feature of the flora as a whole is the complete reversal of the proportions between the angiosperms and gymnosperms as compared with their proportions in the preceding flora, the angiosperms being now overwhelmingly in the ascendant, while in the gymnosperms the conifers are more abundant than the cycads.

The genera also indicate a less tropical climate than that which previously prevailed, but one which was considerably warmer than now obtains in the region.

After the clays had been laid down as estuary or brackish water deposits, the submergence continued, and we next find the clay marls, representing the transition to marine conditions. In these the land vegetation is less abundant, but is not noticeably different in its general characters from that which preceded it.[1]

The subsidence continued and true marine conditions supervened. The marls were deposited, and in them nothing but marine organisms are preserved. Thus far we have not found any record of the land vegetation which occupied the region during this period, but in the west the conditions were different, and the remains of Upper Cretaceous plants are abundantly preserved in the Laramie and allied deposits. In these most of the Middle Cretaceous genera are found to continue, and a number of new ones to appear, but the species in all but a very few instances are different, and the monocotyledons begin to assume prominence for the first time, in the form of fan palms.

Generically this flora is more closely related to our living flora than was that which had preceded it. The number of living genera included in it was actually and relatively greater, and the species are of a more modern aspect; but none is apparently identical with any now living.

---

[1] Hollick, Arthur. The Cretaceous Clay Marl Exposure at Cliffwood, N. J., *Trans. N. Y. Acad. Sci.*, vol. xvi (1897), pp. 124–136.

The ratios between the pteridophytes, gymnosperms, and angiosperms were approximately about as we find them to be at the present time, and the climatic conditions were apparently yet subtropical.

During the early and middle parts of the next succeeding period, the Tertiary, the indications are that while there were minor oscillations of level, the previous gradual subsidence continued until the shore line had advanced far inland, covering the entire region which we know as the coastal plain, and causing the sediments to be deposited which we recognize in the aggregate as the Yellow Gravel formation. In places this is undoubtedly of marine origin, while in others it is apparently due to floods of fresh water. At one locality only, in the vicinity of Bridgeton, has the flora of this period been found in the state. Fortunately the remains there preserved were collected in abundance and in excellent condition. Probably about fifty well-defined species are represented in the collections which have been made; all of them angiosperms; many of them referable to living species, or so closely identical that it is not possible to separate them; some of the latter the same as species now growing in the vicinity of Bridgeton (*Ilex opaca*, *Nyssa aquatica*, etc.).

A comparison between this fossil flora and the living flora of eastern North America indicates a close identity between the former and that now in existence somewhat farther south, say at about the latitude of Virginia.[1]

Theoretically this Bridgeton flora should be Pleiocene or late

---

[1] The study of this flora has not yet been completed, but the preliminary conclusions may be found in the following papers:

Palæobotany of the Yellow Gravel at Bridgeton, N. J. Arthur Hollick. *Bull. Torrey Bot. Club*, vol. xix (1892), pp. 330–333.

New Species of Leguminous Pods from the Yellow Gravel at Bridgeton, N. J. *Ibid.*, vol. xxiii (1896), pp. 46–49.

A New Fossil Monocotyledon from the Yellow Gravel at Bridgeton, N. J. *Ibid.*, vol. xxiv (1897), pp. 329–331.

In the above papers may also be found references to the work of others in the same locality.

Miocene in age, but in many of its elements it is unique, and is distinct from that of any other American Tertiary locality. The collections of Eocene and Miocene plants which have been made in the west contain different species, and those from Bridgeton are rare or else entirely wanting in them. As a whole, however, the flora seems to be more nearly comparable with that of certain European Miocene localities, and this idea is also in accordance with the well-recognized fact that plant development was more advanced in Europe than in America. Thus European Eocene plants are in part represented by Miocene plants in America. European Miocene by American Pliocene, and European Pliocene by our present living flora. From its general character I am inclined to consider it as more recent in age than that of any other recognized Tertiary horizon in America.

Towards the close of the Tertiary period an era of elevation began which raised the northern part of the North American continent many hundreds of feet above its former level and extended the shore line out far beyond its former or present position, so that the edge of the continent was about where we now find the one hundred fathom contour to be.

Up to this time in the world's history we have every reason to believe that there were no extremes of climate between the poles and the equator such as prevail to-day. The temperature of the entire earth's surface was more or less uniform during each of the several periods, up to and including the Tertiary, although a constant change had been in progress from tropical to temperate conditions.

The elevation which began in the Tertiary period, however, caused, or at least was coincident with, the greatest changes, climatic and biologic, which are anywhere recorded in geologic history. The climate gradually became more and more severe, and finally culminated in what we call the Glacial epoch of the Quaternary period.

That the changes wrought were gradual, extending over a long period of time, we are justified in concluding, for the reason that the vegetation which was in existence at the time when it was finally overwhelmed by the accumulations of ice and snow was identical in all respects with that of to-day over the same region. In other words, the flora of the Tertiary period had become modified to the new conditions before its final extermination by the ice sheet, which extended southward in New Jersey as far as Perth Amboy in the east and Belvidere in the west. Every species thus far discovered in the Quaternary clays and gravels, or in old peat bogs beneath the bowlder till, is identical with some living species, and this evidence of modification to meet changing conditions implies a long period of time. Such species as were located within the area of glaciation were of course absolutely exterminated, while others were driven southward, and only such as could exist under these vicissitudes remained to reëstablish themselves after the final recession of the ice.

I do not know of any remains of the vegetation of this period having been found in New Jersey, and such as have been found elsewhere are scanty in amount.

The final recession of the ice was accompanied by a subsidence of the land, and this subsidence was probably the cause of the recession in the same way that the previous elevation had been the cause of its accumulation. Several oscillations of level occurred, and finally the land assumed the contour and topography of to-day.

At the present time, so far as New Jersey is concerned, a slow subsidence of the land is recognized as taking place, which amounts to about two feet per century. This rate of movement, while very slow, is probably no greater than that which produced such tremendous changes of level and such far-reaching effects in the past, and we have but to consider the cumulative effects in order to appreciate that a few centuries hence great changes in topography may be effected. Even within historic times the subsidence of the land has caused the coast line to advance inland in many localities, so that what was once upland has become salt meadow, while salt meadow turf and tree stumps are found far out in the ocean bottom, beyond the present shore line.

Recognizing these facts, the question naturally arises as to the ultimate result, provided the present conditions continue.

Manifestly the flora which occupies the coast region will have its habitat more and more restricted in area, and will be driven more and more towards the tension zone, where the struggle for existence will become fiercer and the weaker elements will succumb. Thus not only are the physical changes in the environment inimical, but also the trend of biologic evolution. The sequence of events in the evolution of the vegetable kingdom show conclusively that the gymnosperm type is a waning one, and that the more highly developed angiosperms have been slowly but inevitably crowding it out since early Cretaceous times, and at the present time, in any competition for the occupancy of a region at all favorable for the angiosperms, these latter are sure to prevail, and the conclusion appears to be inevitable that the flora of the coniferous zone is destined to be ultimately obliterated or only to exist over limited areas, often for the negative reason that in such areas the conditions may not be favorable for the growth of other types. The influence of man may produce temporary changes and give temporary advantage one way or the other, as may often be seen in the occupation by cedars or pines of land which has been recently cleared of deciduous trees ; but such changes are artificial and sporadic and cannot prevail over the constant and inevitable progress of physical and organic evolution.

Not only is the gradual extinction of the gymnosperm type thus indicated, but by the same method of reasoning the angiosperms characteristic of the coniferous zone must of necessity be the first to die out in that class, not only because of the gradual restriction of the area which they occupy, but also because, as is well known, the genera represented are older and the flora as a whole is less modern in its characteristics than obtain in the angiosperm flora of the deciduous zone. The genera of the coniferous zone are largely confined to America, whereas those of the deciduous zone are largely common to both America and Europe. These latter are thus of wide and varied distribution ; they occupy a region practically unrestricted in area, and represent more recently evolved types of vegetation.